Journal of Poverty, Investment and Development
ISSN 2422-846X An International Peer-reviewed Journal
Vol.44, 2018
www.iiste.org

Dissemination, Constraints and Opportunities for Improving Tef Productivity: Evidence from Demonstration Trials

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Abstract
Tef [*Eragrostis tef* (Zucc). Trotter] is the most important food crop in Ethiopia where it is annually cultivated on over three million hectares of land, which is equivalent to 30% of the total area allocated to cereals. Compared to other cereal crops, such as wheat and maize, tef has higher tolerance to unfavorable environmental conditions which include both biotic and abiotic stresses. Since the inception of tef improvement program in Ethiopia in the late 1950s, 42 improved varieties have been released by the national research System. However, cost of production and economic benefit derived from tef farming was not clearly understood.A study was carried out in the field plots of 40 smallholder farmers in four districts (namely, Ada, Gimbichu, Moretna-Jirru, and Minjar-Shenkora) where tef is the major cereal crop in order to assess the economics aspects of the tef faming venture. Three recently released tef varieties Tesfa, Dagim and Boset were used for the study. The yields of the three varieties were comparable (Tesfa = 2.31, Dagim = 2.24 and Boset = 2.12 t ha^{-1}). The average variable production cost for the three varieties was 23,756.09 Birr ha^{-1}. Given the input and output prices that prevail in the selected districts, the lead farmers obtained, on average, a gross income of 36,673.25 ETB ha^{-1}. Analysis of the variable production cost structure revealed that the highest proportion of the production costs across the forty lead farmers went to the cost of labor (63.2%) and fertilizer (18.2%). From the total labor costs used in tef production, the lion's share went to harvesting (57.1%) and weeding (24.8%). Thus, harvesting and weeding are the most critical factors that affect tef production and productivity, and thereby its gross margin.
Keywords: *Eragrostis tef*, Productivity, tef varieties, variable cost and gross margin

INTRODUCTION

Eragrostis tef is the super tiny grain native to Ethiopia, grown in many parts of the country. It is a major staple food in Ethiopia, which is the center of both origin and diversity. It is annually activated on about three million hectares of land, and it covers about 30% of the total acreage of the cereal land (CSA, 2016). Its coverage is increasing from time to time in the farming community without any further promotion or intervention.

The economic advantages of tef to the farming community have been noted in various documents (Seyfu, 1993 and 1997), although there were scholars claiming that it has many disadvantages.

Whole grain *t*ef is a nutritional powerhouse. The calcium content in tef significantly surpasses that of all other grains. By wide margin, tef leads all the grains in its calcium content (Washington Post, 2016; Jeffrey, 2015).

Tef is used to make injera (the sourdough flatbread) with a long list of health benefits: high nutritional value, gluten-free, better to manage blood sugars**,** lower blood pressure and maintain a heart healthy diet (low sodium), low in saturated fat, tastes great and reduce constipation (Washington Post, 2016; Jeffrey, 2015).

In addition to the long list health benefits, tef is resilience to both water-logging and drought compared to other crops but it is labour intensive because of low level of mechanization.

At present, it becomes difficult to grow tef in large scale because planting tef in wet fields and harvesting the lodged tef with the help of farm machinery could not work well. As result, big proportion of labour goes to harvesting and threshing.

The time series data collected for more than ten years at Debre Zeit market indicated that the prices of both the grain and straw had increased steadily. However, the price of tef grain vary at any market day. The factors affecting the prices are assumed to be quality characteristics (grain color, grain size, purity, age and production area) attributed to any tef in the market. Some of the quality characteristics are believed to be either cryptic or evident qualities that manifest themselves in various ways in the market (Gezahegn *et al*., 2005).

In order to bring tef back to the forefront development, we have to achieve large-scale production to improving the livelihoods of smallholder farmers focusing on food security and food crisis, growing farming population, climate change and increasing rural food production to address the rural-urban income gap (Piccinin, 2010).

Better approaches need to be designed to promote technologies, knowledge, policies and institutional frameworks that enable farmers to increase productivity and markets to function well (Ogwal-Kasimiro *et al.*, 2012). If tef productivity is increased, farmers receive benefits both through increased home consumption and through the income generated from tef sales.

As foreigners embrace Ethiopian cuisine, farmers should improve tef productivity through technologies and knowledge transfer (Emily, 2012).

Objectives of the study

The main objective was to disseminate improved tef technology focusing on the constraints to utilization by farmers.

Specific Objectives

The specific objectives developed to guide the study were:

1. Describe the personal characteristics of the tef farmers in the study area;
2. Assess the level of awareness of tef production technology by the respondents or host farmers; and
3. Examine the constraints affecting utilization of tef production technology.
4. Determine how much to produce per unit of area and how much cost incurred to produce a unit of output.

RESEARCH MTHODOLOGY

Study area

Four districts (also known as *Woredas*) in the central highlands of Ethiopia, where tef is the major crop, were selected for the study. These are Ada and Gimbichu districts from East Shewa Zone in the Oromia Regional State, and Moretna-Jirru and Minjar-Shenkora from North Shewa in the Amhara Regional State. The four districts have long experiences in tef farming. Tef and wheat are the major crops, which occupy 75 percent of the total cropped area. Virtually, all farmlands are cultivated and farmers use improved technologies to compensate land scarcity.

Design and sampling

Forty farmers were randomly selected from among 80 lead farmers. Lead farmers refer to smallholder farmers who are ready to test new farming technologies including improved seeds in their fields (Chabata and Judith de Wolf, 2013). Tesfa was a new variety grown by 40 lead farmers. Out of which, based on farmers' preferences, Tesfa and Dagim varieties were grown by 26 and Tesfa and Boset varieties by 14 lead farmers. The varieties were planted side-by-side on the same field and at the same sowing date each on about 0.25 ha in order to compare the results. The seed rate of both varieties was 16-20 kg ha^{-1}, while farmers individually decided on all other agronomic management practices which include frequency of ploughing, time of sowing, time of hand weeding, and type, time and rate of fertilizer application. Moreover, except the seed required for demonstration, the lead farmers used their own inputs and they were also responsible for managing the demonstration trials, while the researcher and the extension agent were responsible for facilitating and providing guidance. The researcher also assisted the lead farmers to ensure that the demonstrations/trials were within their capabilities by keeping field trials as simple as possible (i.e., only one to two treatments) and reflected on what the farmers are currently practicing.

Data collection and analysis

Relevant physical and cost data were collected from the primary sources. Primary data on grain yield, labor and oxen use, and application rates of inputs such as seed and fertilizer were based on the field trials. The data were coded and entered into the SPSS computer software package for analysis. Data were initially analyzed using descriptive statistics such as frequency, percentages, minimum, maximum, means and standard deviations.

Gross margin was calculated as the difference between gross revenue and variable costs. Gross revenue is the value total grain and straw produced at their respective prices. Performance indicator is the ratio between the total output and the total input.

All costs and revenues were quantified based on 0.25 ha land of each farmer which were later extrapolated to the hectare basis.

RESULTS AND DISCUSSION

Survey Results

A. Socio-economic characteristics of tef farmers

(i) Age: The result of the analysis shows that 45% of the respondents were between the ages of 41-50 years, 22.5% were between 31-40 and 17.5% were older (Table 1). This age distribution among farmers suggests high level of vitality for agricultural activities and play central role in tef farming.

(ii) Education: Table 1 further revealed that there is high level of education among the respondents as 65% had attended primary school and the other 25% had attended secondary school. This showed that majority of the respondents are literate. the relative high level of literacy is expected to enhance innovativeness of farmers.

(iii) Farm size: Over one third (35%) of the respondents had more than 2.5 ha while 22.5 % of the respondents were between 2.1-2.5 ha. Almost 20% of the respondents had a farm size between 1.6-2.0 ha. This results indicated that majority of the tef farmers belong to small-scale category. This agreed with the classification of

Abate *et al* (2005), which classified small-scale tef farmers as small and large farms.

(iv) Farming experience: Over one half of the respondents (52.5%) had more than 10 years of farming experiences. The implication of this finding is that majority of the respondents were experienced farmers, who are considered to be responsible and rational in taking decision in farm activities.

Table 1. Socio-economic characteristics of the selected tef farmers (n = 40)

Variables	Frequency	Percentage
Age (years)		
21-30	6	15.0
31-40	9	22.5
41-50	18	45.0
>50	7	17.5
Education		
Illiterate	4	10.9
Primary school	26	65.0
Secondary school	10	25.0
Farm size (ha)		
<1	2	5.0
1.1-1.5	7	17.5
1.6-2.0	8	20.0
2.1-2.5	9	22.5
>2.5	14	35.0
Farming experiences (years)		
1-5	10	25.0
4-10	9	22.5
>10	21	52.5

Level of Awareness of Tef Production Technology

Farmers were asked to indicate their awareness of tef production technology. Five recommended technologies were made available for the farmers to indicate their level of awareness out of two options of Yes or No for each of the five recommended practices.

The result of the analysis presented in Table 2 shows that farmers have low awareness for all the recommended technologies (18%). Low awareness of recently released improved varieties flagged by 37.5% of the farmers, Low awareness of seed and fertilizer rates highlighted by 25 and 15% of the respondents, respectively. The implication of this finding indicates that farmers who are not aware of the technology will not certainly adopt the technology easily.

Table 2. Respondents' awareness of tef production technology (n = 40)

Technology	Awareness			
	Yes	%	No	%
Recently released improved varieties	15	37.5	25	62.5
Seed rate (kg/ha)	10	25.0	30	75.0
Fertilizer rate (kg/ha)	6	15.0	34	85.0
Control of pests & diseases	3	7.5	37	92.5
Improved harvesting technologies	2	5.0	38	95.0

Constraints to utilization of tef production technology

The potential to improve tef productivity is limited by multiple barriers. Among others, inadequate supply of quality seed and farm machinery are critical barriers to increasing tef productivity. These barriers have to be addressed holistically.

The farmers who hosted the demonstration trials were asked to rate the constraints to utilization of tef technology**.** The result of the analysis presented in Table 3 revealed that the constraints to the utilization of tef production technology, as rated by the farmers, is shortage of improved varieties (23.5%) followed by lack of farm machinery for harvesting. Shortage of capital to pay for labour at harvesting (20%) and lack of information on input supply (18.2%) were also the other constraints to the utilization of tef production technology**.**

Table 3. Constraints to utilization of tef production technology (n = 40)

Constraints	**Respondents**		**Percent of cases**
	N	**Percent**	
Shortage of improved varieties	40	23.5	100.0
Shortage of capital to pay for labour at harvesting	34	20.0	85.0
Lack of harvesting technology	38	22.4	95.0
Lack of information on input supply	31	18.2	77.5
Inadequate extension contact	27	15.9	67.5
Total	170	100	425.0*

* Percent exceeds 100 because farmers had multiple responses

Farmers' perceptions of the improved varieties

The way a variety evaluated can vary from farmer to farmer. Yield is not enough parameter farmer use to select a new variety for adoption.

In this study, the common criteria farmers used to select new tef varieties were grain yield, maturity (grain filling), plant height for quality and quantity of straw to feed their animals, shoot fly tolerance and escape from frost. In fact, difference in temperature, rainfall, soil and length of growing period resulted in major variations across the study districts. For instance, Tesfa and Boset varieties yielded well in Minjar-Shenkora and Ada districts because of shorter rainy seasons and high temperatures whereas farmers in Moretna-Jirru and Gimbichu districts were able to choose Tesfa and Dagim because of adequate and extended rainfall.

Eliciting farmers' selection criteria, the overall farmers' evaluation of the new varieties is presented in Table 4.

Table 4. Overall farmers' evaluation of the three varieties using a scale (1 to 5), 2016/17 cropping year

Variety	Grain yield	Maturity (grain filling)	Plant Height	Shoot fly tolerance	Escape from frost	Mean	Rank
Tesfa	4.75	4.78	4.70	4.75	4.93	4.78	1.00
Dagim	4.60	3.53	4.75	4.78	3.35	4.20	3.00
Boset	4.58	5.00	3.78	4.90	4.98	4.65	2.00

Results of the Demonstration Trials

Physical and Economic Data on the Demonstration trials

Physical and economic information on the demonstration trials, as a resource, for development is only just beginning to gain ground in Ethiopia. Policy makers, planners, researchers and extension agents are increasingly recognizing the fact that physical and economic information is indispensible to the development process. One serious constraints to agricultural development is the limited access to economic information on the demonstration trials so far done for a number of years. One get an answer for a question how much tef can farmers produce from a hectare of land at a national level, but it is difficult to get an answer for how much cost incurred to produce that quantity of tef. This study attempted to collect both physical and economic data on the demonstration trials as to express the results in both physical and monetary terms.

Agronomic data

In this study, the same seeding rate, for the three varieties, was used for sowing at all sites but plant population across the selected locations exhibited variability. Thus, at maturity, the plant mean population ranged between 1163 and 1532 per square meter. Plant population variations were associated with seed bed preparation, sowing date, soil moisture status and soil packing at planting. The higher plant population usually has a direct positive correlation with high plant biomass (straw) which is very important in tef production to feed livestock.

Small amount of grain yield difference is observed among the varieties. The low yield obtained at two locations in Morenta-Jirru districts was partly due to shoot fly *(Atherigonahyalinipennis) and* poor moisture conditions during the crop growth stages particularly grain filling and the difference in the use of appropriate cultural management. Higher plant population and better yields obtained at other locations due to the seed bed packing practice after planting, better soil moisture condition at planting and grain filling stages. As indicated in Table 5, the mean shoot Biomass and grain yield range between 8.8 to 10.0 and 2.1 to 2.3 (t ha^{-1}), respectively. The mean harvesting index for the three varieties ranged between 22 to 24 percent.

Table 5. Agronomic-related parameters from tef demonstration trials

Variety	Number of sites.	Plant pop. (No m^{-2})	Plant height (cm)	Shoot biomass (t ha^{-1})	Grain yield (t ha^{-1})	Harvesting index (%)
Tesfa	40	1359.31	107.17	9.99	2.31	23.12
Dagim	26	1531.67	112.72	10.01	2.24	22.38
Boset	14	1162.67	81.08	8.79	2.12	24.11

Economic data

Nature can deliver enough of what is needed to obtain higher yield. But higher yield for small farmers don't necessary mean higher profit if the increase in production costs exceeds the increase in yield. It is, thus, important to record economic data required for such decision making. Here, specific economic data refer to the cost data directly related to technology of tef production employed (seed, fertilizer, labor and draft power for plowing and threshing).

Production costs of the demonstration trials

Production costs of the demonstration trials play an important role in the decision of the farmers. Explicitly or implicitly most of the farmers keep in mind the cost of producing additional units of output from improved varieties. At a given level of prices, a farmers can increase his/her farm income in two ways: (i) by increasing productivity and/or (ii) by reducing the cost of production.

In a competitive market, tef prices are not in the control of an individual farmer because there are large number of farmers who are individually producing very small proportions of total production of a commodity. His/her additional production must, therefore, sell at the same or even lower prices, even though additional production might involve higher costs. The second alternative is to reduce the cost of production of the demonstration trials through rationalization of resource-use with low cost of production factors. Thus, cost minimization is the second alternative that directly adds to the gross margin or profit of the farmers who hosted the demonstration trials.

The production cost of the demonstration trials relative to their prices is an important topic for discussion. Cost of production often becomes a policy issues when farmers complain that the prices they receive for their products do not cover the cost of production. Cost of production here means the expenses incurred per unit of output that include the variable and fixed costs. These expenses are often calculated with relation to a particular amount of product and in a particular time period.

In the production of one unit of tef, for example, there are different costs involved. The major cost items involved in tef production are seed, fertilizers, manpower and oxen traction. In order to make a rational choice from amongst alternatives, the major costs involved in the demonstration trials should, therefore, be considered as they are related to problems in the production of tef.

Estimated inputs used by host farmers

It is easier to obtain information on yield, costs and prices than those on-farm input quantities farmers used for their farms (Abate Bekele and Kebebew Assefa, 2013). The costs of production could be estimated when the farmers keep records on farm input quantities used. Accordingly, producing tef requires substantial amount of labour and oxen-hours, averaging 854.70 man-hours and 459.90 oxen-hours ha^{-1}, respectively (Table 6). Categorically,; greater portion of the labour allocated on harvesting and weeding. The results of the study revealed that the lead farmers used variable rates of DAP and urea. This indicates that farmers did not apply the recommended doses of fertilizer of the studied crop. The mean DAP and urea rates were 215 and 140 kg ha^{-1}, respectively.

Table 6. Amount of inputs, labour and oxen time used for demonstration trials as recorded by the farmers (n = 40)

Parameters	Seed (kg ha^{-1})	Fertilizer (kg ha^{-1})		Labour (man-hour ha^{-1})	Oxen (Oxen-hour ha^{-1})
		DAP*	Urea**		
Minimum	16.00	200	100.00	772.00	408.00
Maximum	20.00	260	200.00	956.00	504.00
Mean	18.30	215.00	140.00	854.70	459.90
St. Deviation	2.00	26.31	41.12	46.05	25.06

*DAP 16% nitrogen and 46% P2O5

**Urea contains 46% nitrogen

Estimates of variable costs.

Given the input prices that prevail in the selected districts, cost of variable inputs of forty lead farmers are summarized on Table 7. The major inputs considered in tef production were seed, fertilizers, labour and oxen for seedbed preparation, sowing, weeding, harvesting and threshing. Product transporting from the farm to homestead (threshing ground), stacking, winning and cleaning costs were not included in the total variable costs.

On average, the total variable costs was Birr 23,756.09 Birr ha^{-1}. The mean labour cost used was 15046.66

Birr ha^{-1}. Meaning that big proportion of the total cost went into labour. Farmers were asked about costing procedures and method of labour payment. Majority (80%) of the farmers reported that hourly labor payment for harvesting always remains higher due to overlapping operations across crops and the time of harvesting for tef should be done within short period of time (one to two weeks). Farmers further explained that neither the migrant labour nor the family labour fulfills the labour demand for harvesting. Thus, to perform harvesting and threshing in a given period of time, we need to think of introducing, at least small size harvesting and threshing farm machinery. Introducing farm machinery is an exciting opportunity to the future of tef farming. Unless we devise something, migrant labourers from other regions may not overcome labour shortages at all times.

Table 7. Variable input costs of tef demonstration trials (n = 40)

Parameters	Seed cost (Birr/ha)	Fertilizer cost (Birr/ha)	Labour cost (Birr/ha)	Oxen cost (Birr/ha)	Total cost (Birr/ha
Minimum	400.00	3750.00	13235.00	3550.00	20517.55
Maximum	500.00	5610.00	16880.00	4440.00	25708.05
Mean	457.50	4372.50	15046.66	4009.00	23756.09
St. Deviation	50.06	757.92	714.23	208.40	1336.18

Production cost Structure

Overall cost structure

Production cost structure signifies the proportion of the overall costs for the inputs applied in the production of tef. The production cost analysis exposed that 63% and 18% of the total production costs across the districts went to labour and fertilizers, respectively (Fig. 2). The average daily Labour wages were higher this production year. This often associated with the low supply of migrant labour, not with high living costs. The labour situation creates a dilemma for the farmers to expand tef production in the future despite National Health Services of many countries have become customers to cater for gluten-intolerant patients (Jeffrey, 2015).

A reasonable amount of cost also went to oxen hour whereas the seed cost was insignificant. The cost structure had revealed that small-scale tef farming appeared to have been absorbing more human resource. It is, therefore, arguable that small-scale farmers should either use labour effectively or use farm machinery to increase tef production per unit area. The cost structure, with high labour cost, imposes the need to use farm machinery in order to decrease cost per operating hour or area cropped per year. Harvesting with sickles and oxen -stamping on dried tef to dislodge the seeds and using pitchfork for throwing the threshed tef into the air (wind) for winnowing will not meet both the domestic and foreign demand, as tef has become a super grain of choice in Europe and North America.

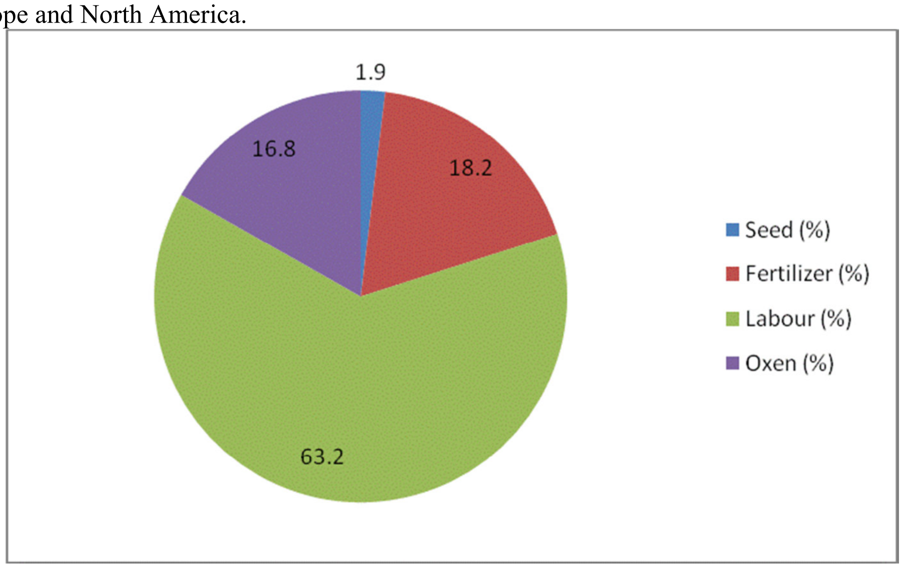

Fig. 2. The cost structure of variable production costs for tef demonstration (n = 40)

Labour cost structure

The bulk of the labour force, in developing countries, is concentrated in agriculture. However, labour becomes very scarce at the time of harvesting due the fact that harvesting needs to be performed within a short period of time to minimize crop loss . When tef matures and rain situation expected the demand for labour gets high and then the wage for tef harvesting increases. Meaning that labour supply fails to keep pace with demand during harvesting, labour prices tend to rise. Thus, introducing farm machinery is the most important sources to overcome this critical shortage of labour during harvesting. It reduces the drudgery of farm work and facilitates better timing of tef harvesting and threshing. The study confirmed that 57% of the total labour cost went to harvesting of tef (Fig.3). Thus, technologies that either replace labour or improve labour productivity in tef production should be sought. Investment in technology help the shortage of labour and smooth the flow of agricultural labour to industrial development (Norton and Alwang, 1993; Mijinadadi and Njoku, 1995; Agwu *et al.*, 2008).

Fig. 3. Labour cost structure categorized into different farm operations (n = 40)

Oxen cost structure

In many developing countries like Ethiopia, oxen are the principal source of power. they plow the fields, carry out planting and threshing. On water- logging fields. on the steep slopes and rough terrain, oxen traction is indispensable. The oxen cost structure revealed that 61% and 28% of the total oxen-hours went to threshing and plowing, respectively. Farmers hired labour and more oxen for threshing to perform it in a given time fearing rainfall.

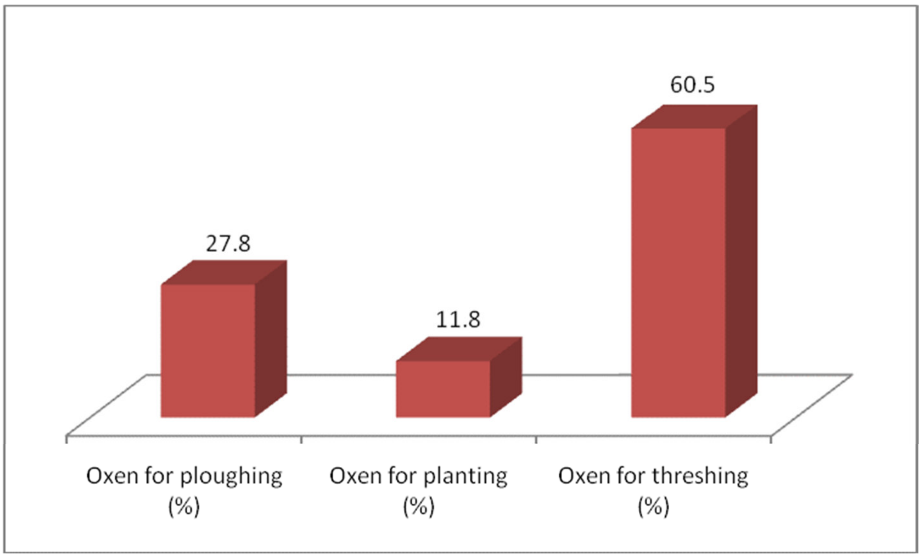

Fig. 4. Oxen cost structures categorized into ploughing, planting anf threshing (n = 40)

Estimates of gross margin or revenue

The goal of farming is to maximize gross margin or minimize production cost for a specified output level. Thus, gross margin of the farm is defined as total revenue minus total variable costs.

Given the input and output prices that prevail in the selected districts, the mean revenue and mea variable costs were estimated to determine the mean gross margin (Table 8).

The mean gross margins were 38,736.88 for Tesfa, 37,345.59 for Dagim and 33.937.27 ETB ha^{-1} for Boset. The mean variable costs were a bit higher in higher yielding varieties because higher-yielding tef varieties required additional labour for harvesting and threshing but it produces more output per unit of land. Tef straw value was taken into account because farmers believe that they stay profitable if the straw either fed to their cattle or sell to the market for different purposes (feed, house plastering, bedding, etc.). Straw prices were collected from the four study districts to estimate the gross revenue obtained from the straw. Accordingly, the total revenue was the sum of revenues obtained from grain and straw yields.

Table 8. Mean revenue, variable costs and gross margin by farmers growing the three improved tef varieties.

Benefits and costs	Improved varieties		
	Tesfa (n = 40)	Dagim (n = 26)	Boset (n = 14)
Grain yield (t ha^{-1})	2.31	2.24	2.12
Straw yield (t ha^{-1})	9.99	10.01	8.79
Total revenue* (ETB ha^{-1})	62,808.00	61,292.00	57,188.00
Variable costs (ETB ha^{-1})	24,071.12	23,946.41	23,250.73
Gross margin (ETB ha^{-1})	38,736.88	37,345.59	33,937.27
Additional gross margin (ETB ha^{-1})	4,799.61	3,408.32	-
Benefit : cost ratio	1.61:1	1.56:1	1.46:1

**Grain and straw priced at 22.0 and 1.2 ETB* kg^{-1}*, respectively*

Performance indicators of the varieties

The central issue of technology dissemination is not the improvement in performance of actors but the improvement in farm input productivity (seed, fertilizer, land and labour) and consequences of technology dissemination on the actors are important indicators (Roling, 2009; Anderson and Gershon, 2004).

Growth in tef output per unit of area and per worker is generally recognized as a necessary condition for economic development. The benefits of improved tef technology in small-scale farming are realized in terms of increase in farm output, higher income and improved standard of living (Hart, *et al*., 2005). Smallholder farmers are characterized by the difference in relative endowments of improved technologies, land and labour. Substantial differences existed in tef productivity are closely associated with changes in the supply of improved technology, land and labour.

Performance indicators in tef vary based on farm size, effective use of improved technologies and labour. Compared to other cereal crops, tef is labour intensive because of low productivity per unit of labour and per unit of land. This can be partly explained by the fact that smallholder farmers cannot afford to purchase improved technologies**.** Tef yield per hectare, tef return per unit of DAP, urea, labour and oxen were the most important performance indicators in tef production (Table 9).

Table 9. Performance indicators of improved tef varieties disseminated to lead farmers, 2018 cropping year

Performance indicators	Varieties		
	Tesfa (n =40)	Dagim (n = 26)	Boset (n = 14)
Average tef yield, kg/ha	2,307.81	2,237.78	2,116.67
Average variable production cost, Birr/ha	24,071.12	23,946.41	23,250.73
Seed multiplication ratio	128.01	125.04	124.67
Tef grain return per unit of DAP, kg	10.79	10.49	10.15
Tef grain return per unit of urea, kg	19.17	18.17	17.80
Labour productivity in tef, kg/man-hour	2.55	2.46	2.29
Oxen productivity in tef, kg/oxen-hour	5.05	4.92	4.66
Variable production cost, Birr/kg	10.43	10.70	10.98

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the field trials, the following conclusions and recommendations were made:

Conclusions

- The target varieties were successfully demonstrated to the lead farmers but they were not further disseminated to other fellow farmers due to seed impurity.
- The yields of the three varieties are comparable (Tesfa = 2.31, Dagim = 2.24 and Boset = 2.12 t ha^{-1}).
- The average variable production cost for the three varieties was 23756.09 Birr ha^{-1}.
- Given the input and output prices that prevail in the selected districts, the lead farmers obtained, on average, a gross income of 36,673.25 ETB ha^{-1}.
- To this end, the average variable cost to produce one kg of tef was estimated at Birr 10.70, whereas, the average current price farmers received per kilogram of tef is Birr 21.00.
- Analysis of the variable production cost structure revealed that the highest proportion of the production costs across the forty lead farmers went to the cost of labor (63%) and fertilizer (18%).
- These findings suggest that small-scale farmers should use farm machinery for harvesting and threshing in order to minimize cost of labour in tef production.
- Despite the multiple barriers to production, farmers were satisfied with the following:
    - The gross benefit gained from tef production outweighs the variable production costs during the study.
    - Producing tef has significant contribution to food security and cash income.
    - Where grazing land scarce, tef straw have high value.

- Processing Enjera from tef saves fuel wood due its longevity (self-life).

Recommendations

- The findings of the study suggest that small-scale farmers should use farm machinery for harvesting and threshing in order to minimize cost of labour in tef production.
- Unless we use improved method of farming, present (ancient) process of harvesting, threshing and winnowing do not make tef production profitable in the long-run.
- Lead farmers' approach found to be the best approach to reciprocate or disseminate improved tef seeds to fellow-farmers.
- Therefore, there is a need to stretch out the approach to similar socioeconomic and agro-ecological conditions in Ethiopia.

Acknowledgements

We would like to thank Syngenta Foundation for Sustainable Agriculture and the University of Bern for financial support. We also thank Debre Zeit Agricultural Research Center for hosting the study. Acknowledgements are also extended to the lead farmers who enthusiastically managed the trials on their fields.

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